

Synthetic biology assemblies for sustainable space exploration

Completed Technology Project (2011 - 2012)



Project Introduction

The work utilized synthetic biology to create sustainable food production processes by developing technology to efficiently convert inedible crop waste to supplemental high-protein food. The technology is based on modular enzyme complexes incorporating components from different organisms that have been shown to convert inaccessible cellulosic biomass like crop waste to soluble sugars more efficiently than enzymes without structural scaffolding.

Long-duration crewed mission beyond low earth orbit will require significant supplies of food and closure of waste loops. Current crop growth systems produce approximately 50% inedible crop waste. Unique NASA-developed synthetic biology assemblies employ biomimicry to improve on naturally occurring enzymatic cellulosomes. These engineered enzyme complexes may be utilized to reduce crop waste by 50% and recover resources for food.

Major constituents of crop waste include cellulose, hemicellulose and lignin. Our bioengineered assemblies would significantly improve the conversion of these constituents to sugars by eliminating the need for chemical pretreatment and reducing the large amount of enzymes typically required. This will be accomplished by engineering synthetic cellulosomes for specific ratios of cellulolytic enzymes that target these specific cellulosic components.

The project completed a number of laboratory assays to compare enzymatic activity on a substrate of a select grouping of proteins attached to our synthetic cellulosome versus the activity unattached, in solution. Selection of groups is based upon reported combinations of enzymes that occur naturally in the cellulosome.

Anticipated Benefits

The application of new technology to help close the carbon loop in life support represents a significant change to the assumptions under which long duration missions are planned.

In particular, the refinement of synthetic biology and cellulosic biofuels contributes to reduced crop waste and helps recover resources for food. This will help enable long-duration crewed missions beyond low earth orbit by increasing availability of food and closing waste loops.

The technology could reduce the mass of crop waste by more than 50% and provide a high-protein food supplement or other chemical resources.



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

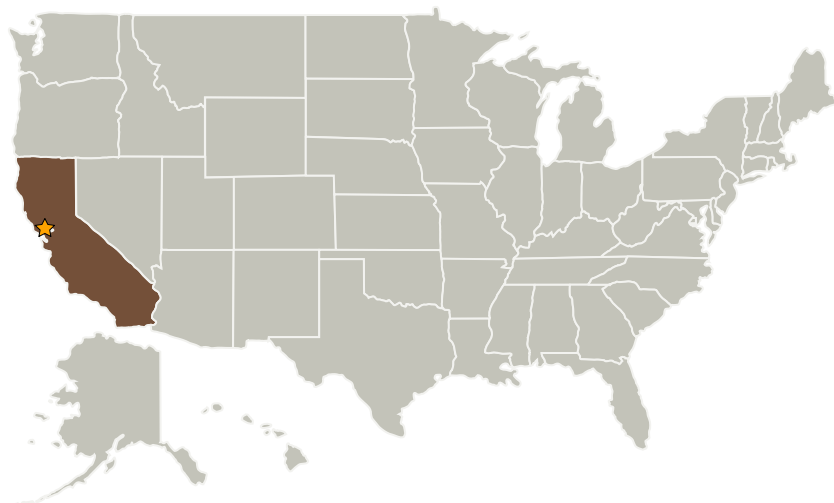
Center Innovation Fund: ARC CIF

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Co-Funding Partners	Type	Location
Department of Agriculture(DoA)	US Government	Washington, District of Columbia

Primary U.S. Work Locations

California

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Harry Partridge

Principal Investigator:

Chad D Paavola

Co-Investigators:

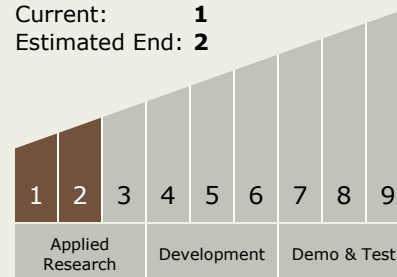
Kurt Wagschal

Charles Lee

Ken Cullings

Technology Maturity (TRL)

Start: **1**
 Current: **1**
 Estimated End: **2**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - └ TX12.3 Mechanical Systems
 - └ TX12.3.7 Mechanism Life Extension Systems